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The effects of seed traits and fabric type on the retention of seed on different types of clothing

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Abstract

People can intentionally or unintentionally transport seed of a diversity of species over long distances, facilitating plant invasions. To better understand factors affecting unintentional human-mediated seed dispersal, we quantified the effects of seed traits and fabric type on the retention potential of weed seed on clothing. First, we compared seed retention among 33 species of weeds that differ in seed morphology using three fabrics. We then compared seed retention for 10 different fabrics using seed from five species of weeds. Retention potential, calculated as the percentage seed retained on fabric after shaking for fixed periods of time, was compared using Linear Mixed Models. Across the 33 species, seed of most species fell off fabric soon after shaking commenced: 17 species had low retention potentials (<20% of the seed remain attached after 5 min of shaking), 10 species had moderate seed retention (20–50% seed retained), and only five species had high retention potentials (>50% seed retained). Retention potentials varied among fabrics, with seed more tightly attaching to fabrics with "woolly" or "fleecy" characteristics such as fleece, knitted wool, double weave wool nylon blend (hiking socks) and ribbed cotton/nylon (sports socks), than to smoother fabrics such as canvas, fine nylon weave, denim and drill cotton. The weight, length and presence of attachment structures affected how long seed remain attached. The effect of these traits varied among fabrics. Seed with structures such as hairs, awns and pappus remained attached for longer on fabrics like fleece and wool, but not on smoother fabrics. These results support the observation that people wearing clothing made of different fabrics are likely to disperse different combinations of weed seed, depending, at least in part, on seed traits. Unintentional human mediated seed dispersal via clothing is therefore a very selective example of epizoochory favouring some weeds more than others.

Zusammenfassung

Berabsichtigt oder unbeabsichtigt können Personen Samen von verschiedenen Pflanzenarten über weite Strecken transportieren und so Invasionen erleichtern. Um die Faktoren besser zu verstehen, die die unbeabsichtigte vom Menschen vermittelte Samenausbreitung beeinflussen, quantifizierten wir die Einflüsse von Samenmerkmalen und Gewebetyp der Bekleidung auf das Retentionspotential von Unkrautsamen. Zunächst verglichen wir für drei Gewebearten das Retentionspotential von 33 Unkrautarten, die sich hinsichtlich der Samenmorphologie unterscheiden. Danach untersuchten wir das Retentionsverhalten von fünf Samenarten auf zehn Gewebearten. Die Gewebeproben wurden für eine bestimmte Zeit geschüttelt und das Retentionspotential als der prozentuale Anteil der noch vorhandenen Samen berechnet. Die Samen der meisten Arten fielen schnell ab: 17 Arten hatten geringe Retentionspotentiale (<20% der Samen verblieben nach 5 Minuten Schütteldauer), zehn Arten hatten mittleres Retentionspotential (20–50% verblieben) und nur bei fünf Arten verblieben mehr als 50% der Samen auf dem Stoff. Die

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Retentionspotentiale variierten mit dem Gewebetyp, wobei die Samen fester an Stoffen mit Woll- oder Fleecestruktur (Fleece, gestrickte Wolle, doppelt gewirktes Wolle-Nylon-Gemisch (Wandersocken) oder Baumwoll-Nylon-Gemisch (Sportsocken)) hängen blieben als an glatteren Stoffen (Segeltuch, feines Nylongewebe, Jeansstoff und Baumwolldrillich). Gewicht und Länge der Samen sowie das Vorhandensein von Haftstrukturen bestimmten, wie lange die Samen haften blieben. Der Effekt dieser Merkmale variierte mit der Gewebeart. Samen mit Haaren, Grannen und Pappi hafteten länger an Fleece und Wolle aber nicht an glatteren Geweben. Diese Ergebnisse unterstützen die Beobachtung, dass Personen, die Bekleidung aus unterschiedlichen Stoffen tragen wahrscheinlich unterschiedliche Kombinationen von Samen transportieren, was zumindest teilweise von der Samenart abhängt. Unbeabsichtigte Samenausbreitung mit der Bekleidung des Menschen ist deshalb ein Beispiel dafür, dass bei der Epizoochorie manche Arten stärker als andere begünstigt werden.

Keywords: Biological invasion; Epizoochory; Human-mediated seed dispersal; Tourism impact; Long distance dispersal; Recreational ecology

Introduction

Dispersal is a key ecological process where plants disseminate propagules (hereafter referred to as seed) far from the source/parents (Howe & Smallwood, 1982; Willson & Traveset, 2000). An important dispersal mechanism is via human-mediated seed dispersal, where people intentionally or unintentionally carry and disperse seed (Ansong & Pickering, 2013a,b; von der Lippe & Kowarik, 2007; Wichmann et al., 2009). This includes seed on clothing, which is a special case of epizoochory, where seed is dispersed on the outside of animals (Cousens, Dytham, & Law, 2008; Pickering, Mount, Wichmann, & Bullock, 2011). With more people travelling and travelling to more remote locations, humans can unintentionally transport seed from a range of species, including weeds, over long distances (Ansong & Pickering, 2013c; Auffret & Cousins, 2013a). This type of long distance dispersal facilitates biological invasions in urban, rural and remote natural areas (Pickering & Mount, 2010; Pyšek, Jarosik, & Pergl, 2011; Ware, Bergstrom, Müller, & Alsos, 2012).

Clothing is an important type of dispersal vector as people can unintentionally carry a range of weed seed on their clothing over long distances (Ansong & Pickering, 2014a; Chown et al., 2012). Seed on clothing can be carried thousands of kilometres, with people travelling to very remote locations, such as Antarctica, found to have weed seeds attached to their clothing (Chown et al., 2012; Whinam, Chilcott, & Bergstrom, 2005). The number of seed attaching to individual items of clothing can be substantial, with over 600 seeds attached to individual socks after 5 min walks through weedy roadsides in a national park in Australia (Mount & Pickering, 2009). A recent review of seed dispersal from clothing found that seed from 450 species have been recorded attached to clothing, 87% of which are considered weeds (Ansong & Pickering, 2014b). Many of these weeds are known to have a range of negative environmental impacts including out-competing native species and altering ecosystem structures and processes. They also reduce the economic value of natural and agricultural areas and increase management costs (Richardson, 2011; Weber, 2003).

Seed dispersal via clothing, as in all epizoochory, involves several steps: seed must first become attached to the clothing, then remain attached (retained) during transportation, and finally be deposited in new sites. Characteristics of the seed and the clothing affect each stage (Ansong & Pickering, 2014b; Ansong, Pickering, & Arthur, 2015). Differences in the size and morphology of seed, for instance, affect the potential for seed to disperse from clothing (Ansong & Pickering, 2014b; Bullock & Primack, 1977). The amount and type of seed dispersed is also affected by where on the body the clothing is worn, if it is covered by other clothing and the behaviour of the person wearing the clothing (Ansong & Pickering, 2015; Mount & Pickering, 2009). The adhesive quality of fabrics is also important, with differences in the number and type of seed retained on clothing such as socks depending on the type of fabric used to make the sock (Bullock & Primack, 1977; Whinam et al., 2005). Previous research has found that seed detach faster from drill cotton trousers than some types of sports socks (Pickering et al., 2011) and that sports and hiking socks vary in the types of seed that attach (Mount & Pickering, 2009). Understanding the importance of seed traits and fabric on seed dispersal from clothing is important when implementing strategies to minimise the spread of invasive species by humans.

Despite its potential importance as a dispersal mechanism, there is still limited research directly assessing seed retention on different types of clothing (Ansong & Pickering, 2014b). Most of the research has been observational or natural experiments where seed were collected from clothing in natural settings or obtained as part of other activities, and the number and types of seed quantified (see Ansong & Pickering, 2014b; Auffret & Cousins, 2013b; Chown et al., 2012). A few studies have used manipulative experiments to assess different factors affecting human-mediated dispersal including types of clothing, species of weed and distances travelled (Ansong & Pickering, 2013c; Bullock & Primack, 1977; Pickering et al., 2011). The literature on seed dispersal from clothing is therefore sparse compared to that